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ABSTRACT

The goals of this study were: (1) to develop a methodology for describing competent classroom teaching performance; and (2) to analyze components of competent classroom decision making to be used in improving preservice and inservice teacher training programs. The study investigated differences in: (1) experienced and novice teachers' reports of cue influence during interactive instruction; (2) actions evoked by cues; (3) goals pursued; and (4) associations between categories of cues and actions. Stimulated recall data were collected from three experienced and five novice teachers during small group instruction settings at a university laboratory school. Results showed that, while both experienced and novice teachers attended to the same number of cue categories, experienced teachers used twice as many kinds of instructional actions and considered a greater variety of goals while exhibiting more complex associations between cue and action categories. Novices were less likely to incorporate spontaneous student input related to lesson content and attended to cues from individual students rather than cues from the group as a whole. The classification scheme for analyzing teacher decision making is presented in the appendix. (Authors/FG)

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A Descriptive Study of Experienced and Novice Teachers' Interactive Instructional Decision Processes

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Abstract

The aim of this study was to develop a methodology for describing competent classroom teaching performance and to analyze components of competent classroom decision making to be used in improving preservice and inservice teacher training programs. Information processing research suggests that expertise in semantically rich domains involves the ability to apply knowledge effectively in response to environmental cues. This study investigated differences in (a) experienced and novice teachers' reports of cue influence during interactive instruction, (b) actions evoked by cues, (c) goals pursued, and (d) associations between categories of cues and actions. Stimulated recall data were collected on three experienced and five novice teachers. Results showed that while both groups attended to the same number of cue categories, experienced teachers implemented twice as many kinds of instructional actions and considered a greater variety of goals, while exhibiting more complex associations between cue and action categories.

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A topic that has received increasing attention in research on teacher instructional expertise is the nature of information teachers process as they make ongoing instructional decisions within the classroom. These studies of instructional decision making have been particularly influenced by theories of information processing within semantically rich domains. Research in this area has highlighted differences in the ways experienced and novice practitioners organize and process complex bodies of information in fields such as physics and medicine, as well as differences in the ways knowledge is applied to problem solving and decision making (Chi, Glaser, & Rees, 1981; Elstein, Kagan, Shulman, Jason, & Loupe, 1972; Kleinmuntz, 1968). A general finding of such studies is that expertise often involves the presence in memory of a well-organized knowledge base and the ability to apply knowledge effectively in response to environmental cues and problem features.

Generalizing these findings to classroom instructional contexts, particularly those aimed at providing classroom instruction that is adaptive to student differences, it may be hypothesized that teaching expertise requires not only a repertoire of knowledge about the subject matter to be taught, but also knowledge about students' learning needs and characteristics, and the ongoing and changing characteristics of the classroom learning environment. This study was designed to investigate interactive instructional decisions within the framework of effective

adaptive instruction. Interactive instruction is defined in the context of this study as the process of adapting instructional plans to the ongoing needs and interests of students within the classroom environment.

While planning outside the classroom is an important aspect of effective instruction, the ability to alter plans to fit current student learning needs is crucial in educational programs aimed at maximizing student learning through providing instruction adaptive to individual students. It has been argued that the ability to process relevant information (cues) about each student's learning, and the nature and demands of the learning task, is essential if appropriate instructional decisions are to be made (e.g., Glaser, 1968; Shavelson, 1981; Wang, 1980; Shroyer, Note 1). Toward this end, teachers must be able to monitor and process student feedback and other environmental cues; integrate cue information with instructional goals and stored knowledge about students and instructional content; and finally, apply this knowledge in making on-the-spot decisions as to how to adapt planned instruction to current environmental conditions and student learning states.

Within the general framework of adaptive instruction, classroom teachers can be viewed as clinical diagnosticians in that they are expected to diagnose individual learning needs of students and make instructional decisions (preplanned or on the spot) that are adaptive to those needs (Glaser, 1975; Shulman & Elstein, 1975; Wang, 1973, 1980). However, teacher diagnostic decision making is complex and differs in several ways from diagnosis in fields such as medicine. In contrast to typical clinical diagnostic settings, teachers must deal concurrently

with a number of students at one time. However, rather than seeing individuals for short periods of time, as in medical diagnosis, teachers see their students every day for 5 hours over a 10 month period of time. Also, the classroom environment is characterized by large amounts of information, with many kinds of stimuli being emitted simultaneously. Further, the classroom has multidimensional qualities, in terms of a number of goal states being possible. In this regard, Doyle (1977) has defined the classroom setting as a system of overlapping task structures with each task consisting of a goal and set of operations. In addition, classroom learning environments contain some information sources that are in a constant change state and are largely unpredictable, as well as other more stable information sources. Given this environment, teacher expertise may be surmised to involve the processing and selective use of a rather complex array of stimuli.

The overall goal of the research reported in this paper is twofold: (a) the development of a methodology for describing competent task performance of classroom teachers providing adaptive instruction, and (b) an analysis of components of competent decision making to be used in designing training programs to improve preservice and inservice teachers' ability to provide classroom instruction that is adaptive to student differences.

Research on Teacher Thinking and Decision Making

The study of ways in which teachers perceive input from the classroom environment and utilize this input to generate appropriate instructional actions has been approached from different perspectives. Some researchers have adopted a theoretical approach through the

development of conceptual models that trace the processes teachers go through during classroom decision making (Collins & Stevens, 1980; Snow, 1972; Shavelson, Note 2). Others have focused on detailed analyses of the classroom performance of teachers to investigate the extent to which teachers engage in interactive decision making, and the nature of the classroom cues and goals that appear to be the most salient inputs into those decisions (McNair, 1978-1979; Peterson & Clark, 1978; Shroyer, Note 1; MacKay, Note 3; MacKay & Marland, Note 4). Research has also focused on the relationship between teachers' interactive decisions and variables such as instructional design, classroom learning environments, and the setting and time of year under which the instruction occurred (Morine-Dershimer, 1978-1979). Research following these approaches is briefly reviewed in the following sections.

Theoretical Models of Teacher Decision Making

Shavelson (1976) outlined a model for classroom decision making, taken from principles of formal decision theory. This model of decision making during interactive instruction focuses on how teachers choose between one teaching act or another at a given point in time, rather than the traditional approach to research on teaching which focuses on the frequency of teacher behaviors utilized over a period of time. In Shavelson's view, the basic teaching skill is the ability to know when to use a particular instructional strategy chosen from an array of alternatives. Five features of classroom decisions are seen as important. These are (a) the choice of teaching acts from alternatives, (b) the environmental cues or conditions to which the teacher attends, (c) the outcome of the teaching decision, (d) the utility of the

teaching decision for the teacher, and (e) the goal that the teaching decision is intended to attain.

The Shavelson model is designed in the form of a decision matrix. Alternative teaching acts form the rows of the matrix, while probabilistic estimates of students' learning states form the columns. Under idealized conditions, the teacher should choose the optimum teaching act for the desired outcome in terms of the estimated student learning state. This desired outcome is represented mathematically within the context of the decision matrix as the largest row sum. Shavelson admits, however, that teachers seldom follow this formal decision model. He proposes that in the classroom, teachers utilize a decision sequence called a TOTE unit. In this sequence, teachers periodically test to determine whether students understand the concept or procedures taught. If the test yields an affirmative answer, the teacher exits and moves on to the next concept. However, if the answer is negative, the teacher operates to execute a teaching act in order to raise the level of student understanding. The teacher then again tests and the cycle repeats itself.

Collins and Stevens (1980) have developed an extensive theory of instructional processes of human tutors who utilize the Socratic or inquiry method of teaching. Their theory is influenced by principles of general problem solving and information processing theory as set out by Newell and Simon (1972). This theory specifies that complex information is processed through the establishment of a problem space with an initial state, a goal state, and a set of procedures to move from one to the other. Collins and Stevens' work focuses on the goals and subgoals of effective Socratic tutors, the strategies these teachers apply to

realize goals, and the control structure used for selecting goals and subgoals. These researchers maintain, as other evidence also suggests (McNair, 1978-1979), that, during instruction, teachers often pursue several goals simultaneously. Each goal has associated with it a number of strategies for selecting cases, asking questions, giving comments, etc.

Collins and Stevens' theory is based on analyses of dialogues from a variety of "expert" teachers including Plato, a preschool teacher, and a professor of artificial intelligence. The theory focuses on teaching that has the purpose of communicating rules or theories of a domain. Three basic subgoals teachers use to achieve this purpose are specified. They are (a) to analyze different cases (or examples) to allow students to derive rules, (b) to debug or correct students' incorrect rules and theories, and (c) to encourage students to make novel predictions based on a rule or theory. In order to accomplish these subgoals, it was found, through protocol analysis, that "expert" teachers use a number of strategies. These strategies are described as condition-action pairs in the manner of computer programs called "production systems." Production systems work in a straightforward manner by testing stored conditions against incoming stimuli (in the case of interactive teaching, stimuli might be composed of a student response). If a student response matches or satisfies a particular condition, the action connected to that condition is executed. One condition-action pair in Collins and Stevens' system is the following:

Condition: If [only] two steps in a causal chain or procedure that are not adjacent have been identified (by the student).

Action: Then ask the student to identify the intermediate steps.

An example of the application of this strategy to a lesson on the causes of rainfall is the following:

Condition: Student: When the moisture-laden air reaches the mountains, it is forced to rise and consequently the air cools, causing rainfall--no?

Action: Teacher: Why does cooling cause rainfall?

In this example, the teacher recognized that a student's reasoning was missing an intermediate causal step, and so the teacher implemented an instructional action to ask the student to provide the missing link. This example is termed an identification strategy as it asks students to identify a factor related to a rule or theory. Other strategies identified by Collins and Stevens through their analysis of instructional protocols include case (or example) strategies, entrapment strategies, and evaluation strategies. Each of these types of strategies is utilized to realize a particular instructional goal in response to an instructional condition or cue.

In addition to specifying instructional goals and strategies of Socratic tutors, Collins and Stevens postulate that teachers also use a dialogue control structure. One important aspect of this control structure is that goals are not prespecified, except for a few global goals. Thus, in Collins and Stevens' view, expert teaching involves the ability to be highly responsive to such ongoing conditions or cues as student responses, and to establish subgoals for dealing with these conditions as instruction progresses. The teacher's agenda is not only

directed by students' responses, however, but is also influenced by the teacher's representation of the structure of the domain he or she is teaching, a set of instructional priorities or principles (for example, correcting errors before omissions), and a model of the student. The student model is conceived to be a structured theory of a domain and, attached to each element, the relative likelihood that any student will know about that element, as well as the underlying misconceptions that students might have about the domain.

Snow (1972) has also proposed a process tracing model for teachers' decisions within the classroom environment (Figure 1). Framed as a flow chart, his model proposes several decision pathways a teacher might trace during the instruction process. He envisions the teacher as constantly monitoring environmental cues within the classroom environment in terms of the model.

Insert Figure 1 about here

If cues are within tolerance, the teacher continues as usual. If not, the teacher notes whether instructional alternatives are available. If they are, the teacher must decide whether or not to change behavior. Thus, this model includes four different pathways the teacher may take based on his or her interpretation of environmental cues. Path one, whereby teachers consider that student behavior is within tolerance, may be considered as "business as usual." Path two, whereby teachers observe behavior outside tolerance but cannot generate alternatives, could be characterized as "teacher surprise." Path three is characterized as a conscious effort on the part of the teacher to continue as usual, even though behavior is not within tolerance and alternatives are available.

Finally, path four is best described as the changing of instructional strategies in response to information from environmental cues.

Analysis of Teachers' Classroom Performance

The Shavelson, Collins and Stevens, as well as Snow models are theories of how teachers make interactive decisions. All of these models place importance on teachers' skill in processing classroom cues, particularly cues from student performance, and teachers' skill in utilizing cue information in order to generate effective instructional actions with respect to a variety of instructional goals. Few researchers have attempted to analyze how teachers with varying characteristics actually perform within the framework of a particular model.

An exception is a study by Peterson and Clark (1978), which applied Snow's model to the analysis of data gathered from 12 teachers operating within a simulated classroom setting. Data were collected using the stimulated recall technique, used in a number of other studies in this area of research, including the one reported in this paper. The teachers were shown videotapes of their classroom teaching performance and asked to recall their thoughts and decisions during the process of instruction. They were independently measured on level of experience, level of aptitude, and approaches to planning. No correlations were found between years of teaching experience or level of conceptual aptitude and path frequency of Snow's model. A positive relationship was found, however, between teachers' planning statements about lesson objectives and frequency of path three in the Snow model (decision to continue behavior in the face of conflicting cue information). This

finding suggests that concentrated detailed planning may inhibit teachers' ability to make instructional adaptations of plans in response to ongoing classroom cues.

Other researchers adopt a more open-ended approach to the study of teachers' thinking and decision-making processes. A somewhat ethnographic style is often utilized without prior application of a particular model. Shroyer (Note 1), for example, sought to describe a segment of mathematics instruction within a natural classroom environment both from the point of view of the teacher and from the point of view of a classroom observer. The units of description were termed "occlusions" or "critical incidents" and referred to classroom events that interrupt the normal teaching flow. Shroyer classified occlusions into three categories: (a) unsolicited student contributions, (b) student errors or difficulties, and (c) on-the-spot teacher planning. In addition, classroom activities were classified for difficulty in terms of errors committed per example worked.

Shroyer was primarily interested in describing the characteristics of occlusions as well as the manner in which occlusions involving activities of differing difficulty were processed by the classroom teacher. Characteristics of the elective actions taken by the teacher in response to processing occlusions were also examined. In examining data from one of the teachers, Shroyer found that the teacher reported attention to slightly less than half of the occlusions recorded by the independent observer (teacher reports were obtained through the stimulated recall methodology). The majority of occlusions that occurred and also the majority of occlusions that were attended to were related to student difficulty. A measure of teacher sensitivity to

classroom input was computed by dividing the number of occlusions attended to and processed by the teacher by the total number of occlusions independently observed. It was found that as activities increased in difficulty, the teacher's sensitivity ratio for student input also increased. Shroyer's study is of interest because it attempts to relate both observer and teacher viewpoints in the analysis of teacher cognition, and thus provides a reference point for comparing teacher interpretations of classroom events.

McNair (1978-1979) investigated teachers' "inflight" concerns during interactive instruction. Stimulated recall interviews were conducted with teachers during fall, winter, and spring, and with lessons conducted with less advanced and more advanced students. Structured probe questions were asked during the interview and responses were coded according to five major categories of teacher concern. These include (a) pupil, (b) content of lesson, (c) procedures, (d) time, and (e) materials. Results indicated that teachers were most affected by their concern for student learning. There was a tendency toward mention of more concerns during lessons with less advanced students, and frequency of concerns did vary systematically over the course of the school year.

Morine-Dershimer and Vallance (1975) conducted an early study of the sources of information teachers utilize during instruction. A contrast was made between groups of teachers whose students showed greater and fewer instructional gains. The technique used was a teacher sort task given to teachers immediately following their conduct of a group lesson. The task consisted of a group of index cards, each card containing the name of a student in the instructional group. Teachers

were asked to group students who behaved in similar ways during the lesson. The teachers' sorting behavior was examined to determine the grouping criteria teachers used, as well as number of groups used. It was found that teachers whose students showed higher gain scores used single element groups more often (that is, groups based on a single criteria), and also used cognitive grouping criteria more frequently than teachers whose students showed lower achievement gain. By contrast, low gain-score teachers frequently used affective criteria to group students, rather than cognitive criteria.

In a later study utilizing a similar pupil sort task given during different situations and at different times of the year, Morine-Dershimer (1978-1979) found that the content of teachers' grouping criteria shifted in focus over different times of the year and within different observational settings. Early in the school year, teachers tended to group students according to personality characteristics, while in November, students were more likely to be grouped according to their involvement in instruction. In June, students were more often grouped according to progress in the curriculum and peer relationships. Morine-Dershimer also found that teachers who worked in individualized settings used a different conceptual structure to group students than teachers within other types of settings. These teachers tended to use fewer, more unique category labels which varied over time and tended to single out students. According to Morine-Dershimer, this pattern indicates a rigidity of concept use which may come about as a result of the increased amount of information about each pupil that must be perceived. It thus appears that the logical structure of teachers' conceptualization of students is at least partly shaped by the curriculum management system used.

Investigations by MacKay (Note 3) and MacKay and Marland (Note 4) have explored teachers' interactive thought processes as well as the relationship between teacher cognition and classroom dyadic interaction patterns. Teacher stimulated recall data were classified according to a micro-analysis of content and characteristics of teachers' thoughts as they related to broad aspects of decision making. Eleven categories of thought content were devised to capture the data, including perceptions, interpretations, tactical plans, predictions, goals, and feelings. It was found that the teachers in the sample spent over half their time during interactive instruction on thoughts that were classified either as tactical plans or reflections (thinking about what had happened during the lesson). Little interactive time was spent on lesson evaluation or setting goals. Related to this finding was the finding that teachers made few instructional decisions involving the consideration of alternatives and that when such decisions were made, no more than two alternatives were usually considered. The above finding is corroborated by other studies of interactive teaching by Clark and Peterson (Note 5) and Morine-Dershimer and Vallance (1975). These results are also related to findings from other studies of expertise in complex domains (Chase & Simon, 1973; Chi, Glaser, & Rees, 1981; Hinsley, Hayes, & Simon, 1978). They have found that experts often do not consider a large number of alternatives in solving problems within domains such as chess, algebra word problems, and mechanics problems in physics, but rather quickly access an appropriate solution path based on their mental representation of the domain.

Rather than decisions involving consideration of alternatives, teachers appear to implement many of what MacKay and Marland (Note 4) call deliberate acts. These acts are heavily influenced by teachers' intuitions about students as well as internalized teaching principles. In this regard, MacKay and Marland found evidence that teachers have extensive case histories of their students in memory as well as a repertoire of teaching principles utilized during the interactive teaching process.

The foregoing review of research on teachers' classroom decision processes reflects the diversity of methodologies utilized by researchers in this area. For example, while Collins and Stevens utilized information processing techniques to model classroom decision processes, other researchers such as MacKay and Shroyer used the stimulated recall technique to gather more open-ended ethnographic data. Alternately, Morine-Dershimer used a sorting task to assess teachers' classroom goals. In spite of the differences in approaches, some basic descriptions and general patterns emerge from the theoretical analyses, as well as from the descriptive and stimulated recall studies.

Models of teachers' thinking and decision making processes have posited the following characteristics of the instructional process: (a) A basic teaching skill is the ability to know when to apply an effective instructional action in response to environmental cues; (b) Ongoing teaching often involves testing cue information against stored knowledge about students, the subject matter, and teaching principles; and (c) Strategies for effective achievement of instructional goals cannot be exactly preplanned, because the strategy selected depends on the nature of environmental cues, particularly student performance cues that arise during the instructional process.

Findings from analyses of teacher performance, on the other hand, seem to suggest the following common characteristics: (a) Teachers probably don't consciously consider a large number of instructional alternatives while teaching, but rather execute "deliberate acts" based on their knowledge of students and the subject matter; (b) While teachers may pursue several instructional goals in the same instructional situation, teachers most frequently pursue instructional goals related to student subject matter learning; (c) Over-rigid preactive planning by teachers may affect teacher flexibility in making interactive classroom decisions; and (d) Teachers' instructional concerns or goals may vary depending on time of year, student characteristics, and the nature of the learning environment.

While this review of recent research on teaching suggests substantial advancements have been made in our understanding of teacher decision making within the classroom, certain limitations may be noted in research completed heretofore in this area. Most studies have not differentiated the level of teacher expertise. Data on teachers' decision processes are aggregated across subjects regardless of whether their level of expertise differs. Therefore it is difficult to abstract from the data these elements of teacher decisions that contribute to competent performance.

Another limitation of research in teacher cognition is that very few studies have attempted to simultaneously examine in actual classroom settings several specific dimensions of teachers' decision processes. It is our contention that such examinations are necessary in order to gain a better understanding of the nature and processes of competent interactive instruction.

The present study was designed to investigate and compare the thoughts and actions of experienced and novice teachers during interactive instruction in classroom settings. The study focuses on teachers' reports of those classroom cues that influenced their instructional decisions, the instructional actions employed, and the instructional goals pursued in response to classroon cues.

Specific questions addressed in this study include:

1. What different kinds and frequencies of classroom cues do teachers report influencing their classroom decision processes within a natural classroom setting and how are classroom cues related to categories of instructional actions?

2. To what extent do teachers change planned instruction on the basis of classroon decisions and what are the kinds and frequencies of instructional actions implemented?

3. What is the nature of the instructional goals teachers report pursuing through the process of classroon decisions?

4. How do experienced and novice teacners differ in their reports of classroom cues leading to decisions, instructional actions implemented as a result of decisions, instructional goals pursued during the decision process, and associations between categories of cues and actions?

Method

Setting

The study was conducted in a university laboratory school. The school utilizes a personalized progress plan as its core approach. This approach features individualized instruction with independent learning and small group instructional activities. The school is organized into three multi-age groupings: a primary level, which includes kindergarten and first and second grades; an intermediate level, which includes third, fourth, and fifth grades; and a middle school, consisting of students in sixth, seventh, and eighth grades. The study was carried out during regularly scheduled small group instruction time. Teacher-led lessons are part of the regular curricula within the teachers' own classroom for small groups (5-8 students). During the time of these lessons, other students in the classroom generally worked on independent assignments.

Subjects

Three experienced and five novice teachers participated in the study. The three experienced teachers were asked to participate on the basis of selection by school administrators as especially competent teachers. The novices comprised all the participants in the school's internship program at the primary and intermediate grade levels, at the time of the study. There were seven females and one male (a novice). One novice and two experienced teachers taught in primary classrooms (first and second grade students). The remaining subjects taught in

classrooms with integrated third, fourth, and fifth grades. The average years of experience of the experienced teachers was 10.1. The novices' experience ranged from a few weeks' experience prior to the beginning of the study to a few weeks plus an additional term of student teaching.

Procedure

Data collection. Stimulated recall data served as the data base for the study. Collection of these data involved a two-step process. First, an approximately 15 minute long segment was videotaped of each teacher conducting a regularly scheduled lesson within his or her own classroom environment. Lessons for each teacher were videotaped, in random order, over a 1 1/2 month period during October and November of the school year. At the beginning of the particular week a teacher was to be taped, the teacher was asked to decide on the lesson in which he or she would be videotaped. Three stipulations were imposed--the selection had to be a small group lesson for five to eight children, the selection had to be a normally scheduled lesson in one of the basic skills curricula, and the lesson had to include active instruction rather than just monitoring of independent work. Although a majority of the lessons taped were in the area of reading and/or language arts (selected by four novices and two experienced teachers), a lesson in mathematics was selected by a novice and a lesson in social studies was selected by an experienced teacher.

One segment of the lesson was taped for each teacher in the study. Each segment consisted of 15 minutes taped after the first 5 minutes of the lesson had elapsed. The teacher wore an inconspicuous microphone during taping. Prestudy taping was conducted to accustom the students and teachers to the equipment and the experimenter.

The second step of the data collection process was carried out the end of the same day that the lesson was taped. Each teacher was shown the segment of his or her own teaching behaviors and was asked to recall any thoughts or decisions made during the instructional process. The interview was conducted by the first author. Prior to the interview, the tape was reviewed by the interviewer to identify instances on the tape where an interactive decision by the teacher appeared to have occurred. A check was made for reliability of identification of interactive decisions. Three tapes were randomly selected to be independently coded by the interviewer and a trained observer. An interrater agreement of .85 was obtained.

At the beginning of the interview, the teacher was asked to stop the tape at any point where he or she recalled any thoughts or decisions. If the teacher didn't stop the tape at the points noted previously by the interviewer as possible decision points, the interviewer stopped the tape and asked whether a decision was made at that point. If the teacher answered negatively, he or she was asked to continue reviewing the tape, but if the teacher answered positively, the interviewer followed the same procedure used for teacher-initiated pauses. At each point where the tape was stopped by the teacher or the interviewer, a series of preplanned probe questions was asked to elicit teachers' recall of the cues, instructional actions, and goals surrounding the decision point. Probe questions included: "What are you aiming at there?" "What are you getting at with that question?" "At that point, what are your thoughts?" "Did you originally plan that?" "What brings that to your mind?" and "What is the reason for that decision?"

A limitation of the stimulated recall technique should be noted at this point. While the technique is designed to probe teachers' recall of their thinking processes at the time of teaching, the technique may also elicit thinking that occurs at the time of viewing of the videotape, and thus not be a pure measure of teachers' interactive decisions. This limitation may be lessened with careful attention to the way in which the interview is conducted. Ericsson (1980), Lynch (Note 6), and Nisbett and Wilson (1977) have presented discussions of this issue.

Data analysis. A two-step procedure was used to analyze the stimulated recall data. First, decision points were identified as points where (a) the teacher spontaneously recalled making a classroom decision or (b) the teacher recalled making a classroom decision following a probe statement by the experimenter. Then, information reported by the teacher was classified in categories under three general headings: (a) the classroom cues teachers reported as leading to classroom decisions, (b) the instructional actions (if any) made as a result of classroom decisions, and (c) the instructional goals teachers reported pursuing during the decision.

The specific categories identified for each of the three major headings were developed from an analysis of the Collins and Stevens (1980) theory of interactive teacher cognition, Shavelson's (Note 2) work on teacher decision making, and preliminary classroom observations by the authors. The classification scheme for each of the three dimensions of teacher decision making addressed by this study is presented in the Appendix.

Transcripts of the protocols obtained from the teacher interviews were classified into categories using the three dimensions of the classification scheme. The classification was carried out through reference to both the teacher report protocols and the videotaped lessons upon which teachers based their reports. The protocols were classified by both the first investigator and an independent rater trained in the use of the scheme. Average percent agreement for the classroom cues dimension, instructional action dimension, and instructional goals dimension was .86, .75, and .83, respectively. Overall agreement was .81.

Results

Protocols obtained from the teacher interviews were analyzed to provide a summary description of the kinds of classroom information teachers consider when making in-class instructional decisions, the nature of the instructional changes teachers make in their preconceived instructional plan, and the specific goals teachers pursue in the process of adapting instruction to current classroom constraints. The results are presented in sequence in accordance with the four basic questions the present study was designed to address. The data are summarized in order to permit easy comparison of characteristics of experienced and novice teachers' decision process.

Decision Frequency

To investigate the nature and pattern of interactive teaching decisions, the data were first analyzed to determine the overall frequency of decisions made during the 15 minute instructional segment

by experienced and novice teachers. As expected, differences in the frequencies of decisions made were found between the two groups of subjects. The average number of decisions made by novice teachers was 7.4, with a range of 4 to 11, while each of the three experienced teachers made approximately 10 instructional decisions during the same unit of instructional time. The data suggest that either the novice teachers do not recognize the need for making changes or are not as flexible (or resourceful) in making the instructional changes required.

Classroom cues. Teachers' reports of cues influencing their decisions are summarized in Table 1. Two kinds of cues are examined; student performance cues and non-student cues. The table indicates the variety of categories utilized by subjects at least once in their decision processes, as well as the percentage of the total number of cue reports accounted for by each of the categories.

Insert Table 1 about here

Near the bottom of the table, the row labeled "% of Total No. of Categories Reported by Each Subject" tells the number of categories of cues reported by each subject at least once divided by the total possible cue categories. For example, Subject A reported attending to five different categories of classroom cues at least once during her report protocol out of a possible eight classroom cue categories or 63% of the total possible categories. The bottom row of the table reports the average number of categories reported divided by the total possible categories for experienced teachers as a group and for novice teachers as a group. Experienced teachers, for instance, cited 67% of the total possible cue categories.

The results shown in Table 1 may be summarized as follows:

1. Except for Novice A, the experienced and novice teachers cited approximately the same number of different kinds of cue categories, suggesting that novices are able to notice a number of cue dimensions within the classroom environment that is similar to the number of cue dimensions noticed by experienced teachers.

2. Experienced and novice teachers reported devoting most attention to different categories of cues. For example, novices reported focusing on disruptive behavior most frequently of all the cue categories. As shown in Table 1, 27% of all cue reports by novices were related to disruptive behavior. Experienced teachers reported disruptive behavior cues as only 6% of their total cue reports. "Lack of Response" and "Spontaneous Initiation" were cited most frequently by experienced teachers as cues influencing their classroom decision processes (29% and 23%, respectively). These cue categories were reported less frequently by novice teachers. "Lack of Response" was cited in 16% of the novices' cue reports and "Spontaneous Initiation" in only 8% of the reports.

These results suggest that, for experienced teachers, classroom decision points are often reached when teachers perceive a lack of appropriate response or an unplanned initiation on the part of students. It appears, however, that novices may be less able to incorporate spontaneous student input related to the lesson as well as experienced teachers, but instead are sensitive to student behaviors that will potentially disrupt their planned presentation.

An additional analysis not reported in Table 1 yielded the finding that experienced teachers reported an equal number of cues involving the instructional group as a whole (for example, "They weren't understanding what I was saying"), as involving individual students (for example, "She wasn't paying attention"). By contrast, novices reported attention to twice as many individual cues as opposed to group cues. This result suggests that novice teachers may be unable to easily focus on input from more than one student at a time.

Instructional actions. Table 2 presents results in the same format as Table 1 with respect to teachers' reports of instructional actions implemented as a result of classroom decisions. These results show that many of the teacher-implemented actions involved refining already presented instruction, engaging student involvement with material and eliciting student input. This is reflected in a high percentage of reports citing the following categories: (a) elicits/provides examples, (b) elicits/incorporates student input, (c) implements management procedure, and (d) focuses student attention.

Insert Table 2 about here

It was also found that novices frequently made changes involving reprimanding or implementing management procedures (17%). Experienced teachers used the techniques of eliciting and providing examples with a frequency of 21% of their total instructional actions, and eliciting and incorporating student input with a frequency of 17%. Overall, experienced teachers appeared to more flexibly implement a larger number of different kinds of instructional actions (an average of 62% of the total possible categories) as a result of their classroom decisions,

whereas the novice subjects limited themselves to fewer kinds of alternatives (an average of 33% of the total possible categories). These results, combined with the results in Table 1, suggest that the novices in this study may be able to notice classroom cues nearly as well as experienced teachers, but lack the ability to translate this information into the implementation of a large variety of instructional actions.

Instructional goals. In Table 3, teachers' reports of goals pursued during interactive instruction are summarized in a manner similar to the data presented in Tables 1 and 2. As shown in the table, the categories of goals most consistently and frequently considered were "Student Understanding" and "Student Motivation and Involvement." A high percentage of teachers reported the goal of "Group Management" at least once, although the relative frequency of reporting this goal was low. Thus, it appears that, while teachers consider a variety of instructional goals during a lesson in response to classroom events, addressing different specific goals at different times, they most often focus on the facilitation of student understanding and motivation.

Insert Table 3 about here

Experienced teachers cited a somewhat greater variety of goals in the process of making classroom decisions than novice teachers. For example, only one novice reported consideration of the goal of facilitating social development as a basis for classroom decisions, while all of the experienced teachers reported this as a goal considered.

Relationship Between Student Performance Cues and Instructional Actions

Thus far, the reported results have characterized the nature and patterns of teacher report data under each heading of the classification scheme for experienced and novice teachers. However, the relationship among the categories of student performance cues teachers reported attending to and the categories of instructional actions applied in response to these cues at different points in the instructional process is also of interest.

Table 4 charts the categories of instructional actions made in response to each category of student performance cue by both experienced and novice subjects. For this analysis, only student performance cues, rather than the full range of classroom cues, were examined. The table shows that novices tended to utilize only one or two kinds of instructional actions in response to a given cue category with a maximum of four action categories being implemented for one of the cue categories. By contrast, the experienced teachers utilized a greater variety of actions. As an example, four to nine different kinds of instructional actions were implemented in response to the categories "Lack of Response," "Spontaneous Initiation," and "Level of Attention." Also, at different times during the videotaped segments, experienced teachers used an instructional action in response to more than one cue category. For example, the instructional action "Probes" was implemented in response to both the "Lack of Response" and "Spontaneous Initiation" student performance cue categories. These findings suggest not only that experienced teachers have a greater repertoire of instructional actions than the novices, but also that these actions are

linked to perceptual cues in more complex ways.

Insert Table 4 about here

Figure 2 provides a graphic representation of the relationship between reported categories of student performance cues and the associated instructional actions made in response to those cues for Experienced Teacher A and Novice Teacher B. It may be seen that the experienced teacher's reports form a more complex, connected representation than those of the novice subject. For Experienced Teacher A, the cue category "Lack of Response" elicited six different kinds of instructional actions at different points in the lesson. Also, the action category "Retreats to Prerequisite Skills" was elicited by two cues, "Lack of Response" and "Insufficient Data." The novice representation, by contrast, shows, at most, only two actions connected to a single cue. Also, no action category was elicited by more than one cue.

Insert Figure 2 about here

Summary and Discussion

This study suggests differential patterns in the thinking processes of experienced and novice teachers during classroom instruction. Differences between experienced and novice teachers were found primarily in the failure of novices to implement as large a variety of instructional actions in response to each type of environmental cue, and in the lesser ability of novices to incorporate spontaneous student

input related to lesson content. Novices also tended to attend to cues from individual students rather than cues from the group as a whole, while experienced teachers attended to individual and group cues equally. In addition, there was some suggestion that experienced teachers considered a greater variety of instructional goals in making classroom decisions. Furthermore, links between categories of reported instructional actions and categories of reported student performance cues were found to be more complex for experienced teachers than for novice teachers.

The study also supports earlier research findings on characteristics of teachers' classroom decision processes, including (a) the ability of teachers to flexibly attend to a number of kinds of classroom cues, (b) the ability of teachers to attend to multiple instructional goals, and (c) the dominance of decision processes with goals related to student understanding and motivation.

Study findings, however, must be interpreted in light of several limitations of the study design. These limitations include the small number of subjects and limited amount of teaching time sampled, as well as problems associated with use of the stimulated recall technique in gathering data. As discussed earlier, this technique is designed to measure teachers' recall of their thought processes at the time of teaching, but may also include thoughts occurring while viewing the tape.

Nevertheless, the results of the study do suggest some major differences between experienced and novice teachers' interactive decision processes that bear further investigation. Replication studies with a larger sample of teachers in a variety of classroom settings may

prove fruitful for specifying areas upon which to focus teacher training efforts.

Additionally, research might be conducted to relate experienced and novice teachers' thought processes to their observable actions as measured by an independent observer. This type of study would provide data on how the information teachers consider is related to the actual teaching strategies they implement. It might also be instructive to investigate teacher cognition from the perspective of the prior knowledge teachers bring to the instructional arena. Such information might include knowledge of students' learning history gained from previous experience with the student and from written records, as well as knowledge of the common errors students make, the important areas of subject matter to stress, and the theories of instruction that might best be utilized to assist learning progress. To date, research has not been done to elucidate whether and how teachers use their knowledge during ongoing instruction and how the nature of teachers' knowledge affects their instructional decisions.

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Appendix

A Classification Scheme for Three Dimensions of Teachers' Interactive Instructional Decisions

Joan L. Fogarty

This classification scheme is composed of categories developed to describe three dimensions of teachers' interactive instructional decisions. These dimensions are:

1) Cue information. That group of reported classroom events that lead teachers to consider implementing an instructional action.

2) Instructional actions. The actual instructional behaviors teachers implement as a result of their classroom decisions.

3) Instructional goals. The goals or instructional aims teachers report pursuing during their classroom decision processes.

In the following sections, categories, definitions of categories, and examples from teacher report protocols are presented for the three dimensions of the scheme.

I. Cue Information

A. Student Performance Cues

1. Lack of Response

Definition:

The teacher reports that a behavior or response expected by the teacher, in accordance with plans, is not made by the student or students.

Example:

In reading sentences aloud in unison, a decision point occurred when a teacher reported that children seemed unable to respond. "This just fell...they didn't respond and that's interesting, but most groups would have been thrilled to have read the story together and it was interesting to me, I think I probably stop a number of times, I really thought they'd be able to do it...."

2. Spontaneous Initiation

Definition:

The teacher reports that students are manifesting behaviors or making responses that are unexpected or are not included within planned instruction.

Example:

A teacher reported a decision point when a student spontaneously praised another student's response. "That was so beautiful the way he responded in such a nice way...it was good to be able to pick up on that because D. is such an "I" person

where he's always doing what he isn't supposed to be doing and not always involved with us...and he did very well on that of being able to respond."

3. Response Error

Definition:

The teacher reports that students make a response in accordance with planned instruction, but that the nature of the response is incorrect, insufficient, or unnecessary.

Example:

A teacher reported making an instructional decision when a student misplaced a symbol on a map key. "It was obvious, I think, that Eva didn't realize that part of it was water and part of it was land, because she put the city in the middle of the water."

4. Disruptive Behavior

Definition:

The teacher reports student behavior is not appropriate or disruptive to the conduct of the lesson.

Example:

A teacher responded to a student's restless behavior: "He tends to get restless. Some of it is just he does that a lot...all it takes is for me to answer a question, even if it doesn't really have to do exactly with what we're concerned with right then, at least it will bring him back on task and he won't disrupt the children."

5. Level of Attention or Interest

Definition:

The teacher reports noticing the level of student attention or interest is either above or below expected levels.

Example:

A teacher reported making a classroom decision on the basis of the students' level of enthusiasm for composing the ending sentence of a story. "They were all excited about an ending sentence because it was a birthday cake that was shown in the last picture so I felt that probably it would be best to get everybody's ending because everybody was enthused and involved at that point of wanting to give an ending rather than just choosing one."

B. Non-Student Cues

1. Insufficient Data

Definition:

The teacher reports that he or she senses a lack of required information on the level of a student's knowledge or understanding of a concept.

Example:

A teacher reported a decision point after being unsure of whether a student was having problems with a math concept: "I wanted to see if she understood what she was saying, the relationship between division and multiplication. She was just

sort of repeating 2X5 equals 10 or 5X2 equals 10 or something like that."

2. Spontaneous Appraisal

Definition:

The teacher reports that previously unplanned instruction is thought of during the course of the lesson, not in response to any particular student cue, but rather through the presentation of subject matter.

Example:

A teacher made a decision to add an instructional segment on the location of the Great Barrier Reef to a lesson in geography. "In my teaching, if something comes into my head, I'll try to illustrate it a little bit more, make it a little more real than just the map they're looking at on there and I find that if we have news and we're talking about a certain area, to pull the map down and show them exactly where it is, which is what I was trying to do here."

3. Lesson Plans Insufficient, Unnecessary, or Incorrect

Definition:

The teacher reports that the original examples he or she planned to use seem insufficient, unnecessary, or incorrect at the time of presentation.

Example:

A teacher reported thinking that the activity she had chosen for a story folder was not going to be appropriate. "What I

had in mind there was originally to cut them (pictures in a student magazine) apart. I realized we weren't going to get through the whole booklet and the lesson was getting way too long for them so we needed to stop, so instead of cutting it apart...I thought, we need to do a writing lesson (using the pictures) but we need to fit in."

II. Instructional Actions

A. Repeats Instruction

Definition:

The teacher repeats directions or lesson content.

Example:

A teacher repeated the directions for placing symbols on a map after noticing a child was distracted when she gave the original directions for the task.

B. Retreats to Prerequisite Skills

Definition:

The teacher presents lower-order skills or concepts underlying higher-order skills or concepts.

Example:

When a student had difficulty reading a word on a sentence card, a teacher brought back a card with just the single word and asked the student to sound it out.

C. Elicits/Provides Examples

Definition:

The teacher elicits or provides examples that generalize or apply an already presented topic or concept, or, alternatively, elicits or provides examples that differentiate concepts into narrower categories.

Example:

A teacher differentiated land masses from bodies of water on a map after she noticed that a student placed a symbol of a city in the middle of a body of water.

D. Explains Procedure

Definition:

The teacher provides or elicits explanation of a set of steps for completing a task.

Example:

A teacher asked students to tell her the procedure for a game they will play in order to practice differentiating the words "this" and "that," after being unsure that the students knew the rules.

E. Alters Pace

Definition:

The teacher speeds up or slows down the pace of the lesson.

Example:

A teacher noticed that students were getting restless, so she speeded up the language lesson by omitting one of the reading aloud procedures she had planned.

F. Checks Knowledge

Definition:

The teacher queries a student about what the student knows about a concept, topic, or procedure.

Example:

After a teacher noticed that the students weren't contributing, she asked them to "name some things you know are made of cotton."

G. Focuses Student Attention

Definition

The teacher directs student attention to a concept or lesson topic.

Example:

A teacher placed a word card directly in front of a student and asked him a question after noticing that the student's attention was wandering.

H. Probes to Elicit Target Response

Definition:

The teacher queries a student to elicit a specific response.

Example:

A teacher asked a student the difference between a reef and an island after being unsure that the student was aware of the distinction.

I. Analyzes Error

Definition:

The teacher compares student procedure for arriving at an answer with the correct response, pointing out the error.

Example:

After a student answered the problem 6-6 with "36," a teacher corrected the error and stated, "6-6? Why did you put 36? Huh? OK, you had 6 all together. Look at the problem, 6 bottles, 6 in each pack. How many packs are there? 36 packs? There's only one in the picture."

J. Adds New or Changes Content

Definition:

The teacher adds new unplanned instruction.

Example:

A teacher spontaneously illustrated the location of the Great Barrier Reef on a map in the room following a discussion of the definition of the word "reef."

K. Implements Management Procedure

Definition:

The teacher makes a reprimanding statement to a student or implements a previously unplanned procedure to manage instructional flow.

Example:

Noticing that the noise level in the room was high, a teacher asked students to talk more quietly.

L. Makes Future Plans

Definition:

The teacher defers changes in instructional plans until some future time.

Example:

After noticing during a reading lesson that students didn't understand the directions North, South, East, and West, a teacher made plans to conduct a future lesson on that topic.

M. Elicits/Incorporates Student Input

Definition:

The teacher encourages student initiations and uses them in the lesson.

Example:

Noticing that students were enthused about composing the ending sentence for a story, a teacher asked for each student's ending, in turn.

III. Instructional Goals

A. Student Motivation and Involvement

Definition:

The teacher makes a decision with consideration for increasing or maintaining students' motivation or involvement with the lesson.

Example:

A teacher made a decision to allow a student to work independently on his own suggested activity, giving the following reason: "I sort of wanted to allow T. to do what he wanted to because he's a very creative child when it comes to drawing and illustrating...I need enough activities for T. like that to hold the rest of his interest because he knows he has difficulty reading and he's not reading at the level he should be."

B. Group Management

Definition:

The teacher makes a decision with consideration for the effect of overall group process and/or structure on the lesson.

Example:

A teacher made a decision to answer a student's question, even though it was irrelevant to the lesson, giving the following reason: "All it takes is for me to answer a question, even if it doesn't really have to do exactly with what we're concerned

with right then, at least it will bring him back on task and he won't disrupt the other children."

C. Curriculum Integration

Definition

The teacher makes a decision with consideration for the sequence of lesson content and/or its integration with later activities.

Example:

A teacher made a decision to continue an activity even though its wasn't working out well, giving the following reason: "(I decided to) just finish it up...because our next activity was going to be writing it. If I stopped, I think I would have lost him."

D. Social Development

Definition:

The teacher makes a decision with consideration for the children's social learning and/or developmental needs.

Example:

A teacher made a decision to allow a particular student to contribute when she raised her hand, even though other students raised their hands first, giving this reason: "I'm finally getting her out of her shell."

E. Subject Matter Content

Definition:

The teacher makes a decision with consideration for the nature of the lesson content.

Example:

A teacher made a decision to probe for more specific responses in a sentence composition lesson, giving the following reason: "I was trying to do this in terms of words that might be more descriptive of what it was going to be used for...just to show we don't want to start every sentence with the same word."

F. Student Understanding

Definition:

The teacher makes a decision with primary consideration for increasing students' ability to understand the lesson content.

Example:

A teacher made the decision to add an unplanned instructional example, giving the following reason: "That came into my head to use that example...I think it helps them to hopefully to relate to a delta (the term being taught)."

Table 1
Categories and Percentage Frequency of Classroom Cues Reported by Experienced and Novice Teachers

	Experienced Teachers				Novice Teachers					
	Subjects Reporting Category at Least Once			% of Total No. of Cue Reports	Subjects Reporting Category at Least Once					% of Total No. of Cue Reports
	A	B	C		A	B	C	D	E	
Lack of Response	X	X	X	29		X	X		X	16
Spontaneous Initiation	X		X	23	X	X	X			8
Response Error		X		6	X	X	X		X	14
Disruptive Behavior	X	X		6	X	X	X	X	X	27
Level of Attention	X		X	13			X	X	X	16
Insufficient Data		X		3		X		X	X	5
Spontaneous Appraisal		X	X	10			X	X		8
Lesson Plans Insufficient, Unnecessary, or Incorrect	X	X	X	10			X		X	5
% of Total No. of Categories Reported by Each Subject	63	75	63		38	63	88	50	75	
Average % of Categories Reported by Each Group			67						63	

Table 2
Categories and Percentage Frequency of Instructional Actions Reported by Experienced and Novice Teachers

	Experienced Teachers				Novice Teachers					
	Subjects Reporting Category at Least Once			% of Total No. of Action Reports	Subjects Reporting Category at Least Once					% of Total No. of Action Reports
	A	B	C		A	B	C	D	E	
Repeats Instruction		X		3		X				3
Retreats to Prerequisite Skills		X		3					X	3
Elicits/Provides Examples	X	X	X	21	X	X		X		14
Explains Procedure		X		3			X		X	10
Alters Pace			X	3						
Checks Knowledge	X			3		X				3
Focuses Student Attention	X	X	X	10			X		X	14
Probes	X		X	7		X			X	10
Analyzes Error		X		3		X				3
Adds New or Changes Content	X	X	X	10	X		X		X	10
Implements Management Procedure	X	X		7		X	X		X	17
Makes Future Plans		X	X	7						
Elicits/Incorporates Student Input	X	X	X	17	X		X	X		10
% of Total No. of Categories Reported by Each Subject	54	77	54		23	46	38	15	46	
Average % of Categories Reported by Each Group			62						33	

Table 3
Categories and Percentage Frequency of Instructional Goals Reported by Experienced and Novice Teachers

	Experienced Teachers				Novice Teachers					
	Subjects Reporting Category at Least Once			% of Total No. of Goal Reports	Subjects Reporting Category at Least Once					% of Total No. of Goal Reports
	A	B	C		A	B	C	D	E	
Student Motivation and Involvement	X		X	28		X	X	X	X	26
Group Management	X	X	X	10	X		X	X	X	14
Curriculum and Integration	X		X	9			X			3
Social Development	X	X	X	9					X	3
Subject Matter Content	X	X		6		X	X	X	X	20
Student Understanding	X	X	X	38	X	X	X		X	34
% of Total No. of Categories Reported by Each Subject	100	67	83		33	50	83	50	83	
Average % of Categories Reported by Each Group			83						60	

Table 4
Categories of Instructional Actions Made in Response to Each Category of Student Performance Cue

	Types of Cues											
	Lack of Response		Spontaneous Initiation		Response Error		Disruptive Behavior		Level of Attention		Insufficient Data	
Types of Actions	Experienced	Novice	Experienced	Novice	Experienced	Novice	Experienced	Novice	Experienced	Novice	Experienced	Novice
Repeats Instruction	X	X										
Retreats to Prerequisite Skills	X		X	X					X			
Elicits/Provides Examples	X	X				X						
Explains Procedure	X	X										
Alters Pace									X			
Checks Knowledge	X											X
Focuses Student Attention	X						X	X	X	X		X
Probes	X	X	X									
Analyzes Error					X	X						
Adds New or Changes Content	X		X	X								
Implements Management Procedure							X	X	X			
Makes Future Plans	X											
Elicits/Incorporates Student Input			X					X	X	X	X	
Total No. of Action Categories Implemented	9	4	4	2	1	2	2	3	5	2	1	2

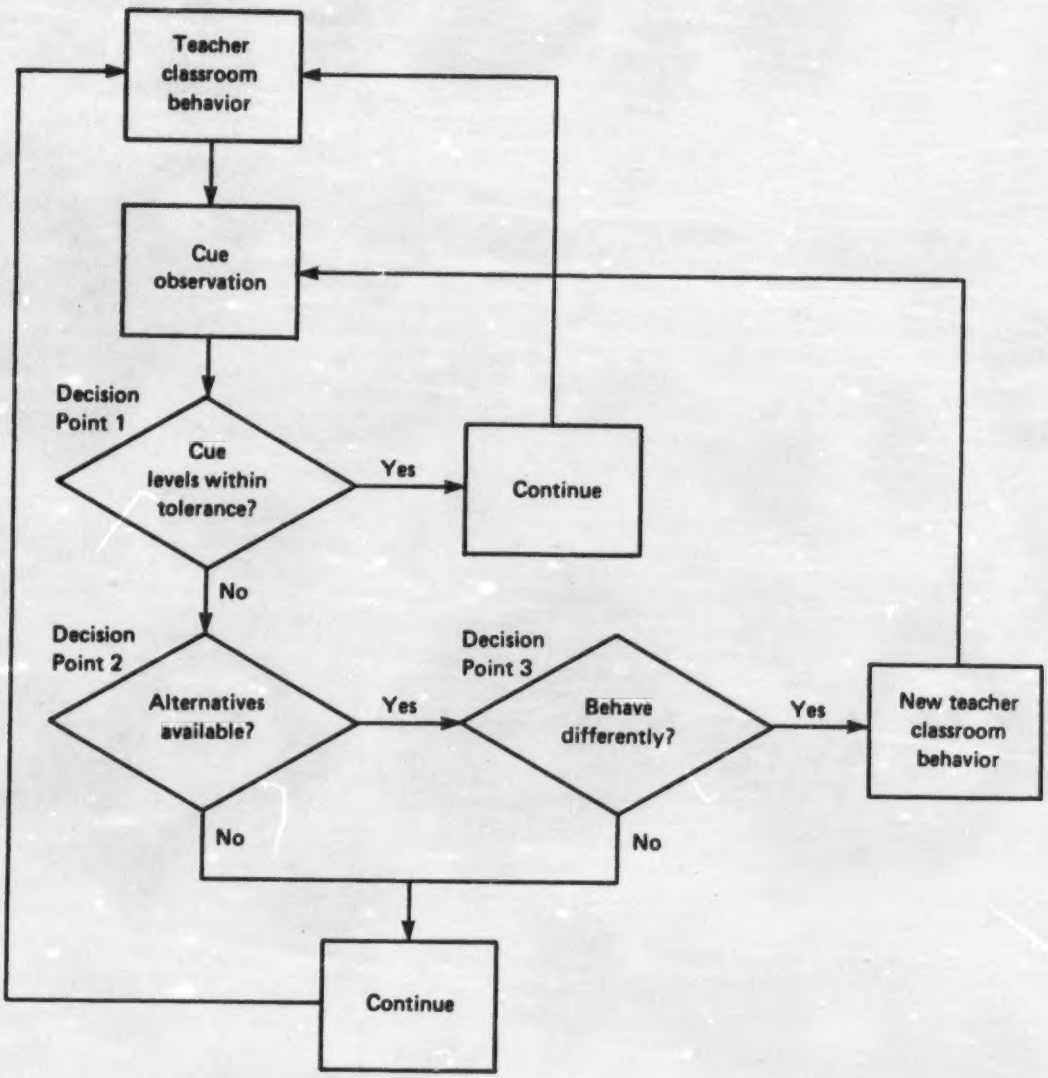

Figure 1. Model of a teacher's cognitive processes during teaching. (Adapted from Snow, 1972).

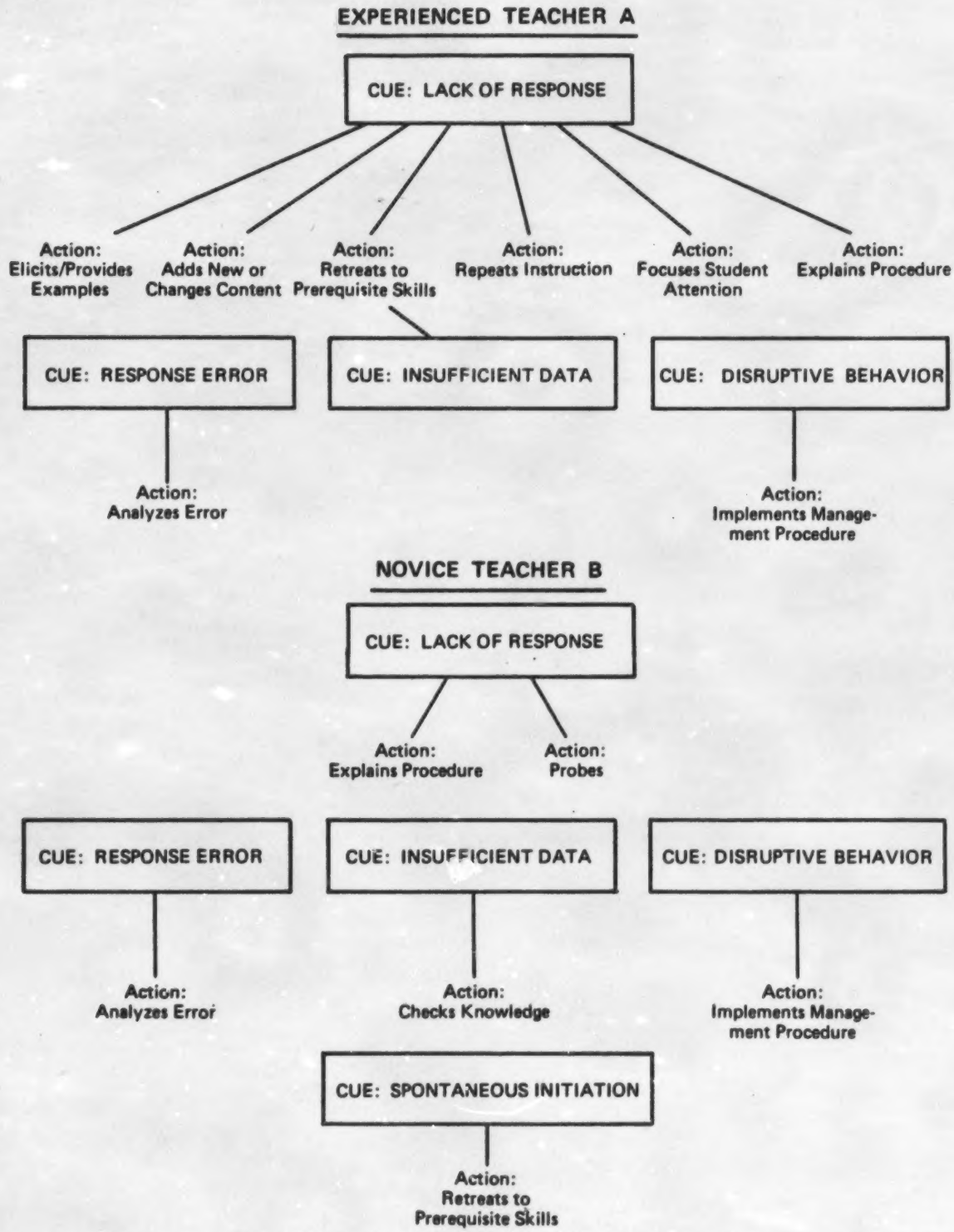

Figure 2. Graphic representation of association of cue and action categories of experienced Teacher A and Novice Teacher B.